BOEING PROPRIETARY

CBC

BOEING

INVENTION DISCLOSURE

This form is to be used for disclosure to The Boeing Company of inventions, discoveries, improvements or innovations, whether or not considered patentable.
See above for instructions.

A — TITLE OF INVENTION (Descriptive and Concise)

Method and apparatus for providing television and data services to mobile platforms

B — INVENTOR INFORMATION (Use Additional Sheet If Necessary)

	1	2	3	4
INVENTOR NAME (FIRST, M.I., LAST)	Greg A. Bengeult	Jeffrey P. Harrang	William R. Richards	Michael G. Lynch
SOCIAL SECURITY NO.	538-54-3536	543-58-0069	371-60-6295	349-56-7839
ORG. NO.	7-U7DE	9-5552	7-U7DE	7-U7DE
MAIL STOP	6E-22	6E-22	6E-22	6E-22
PHONE	425-477-3445	425-477-3455	425-477-3464	425-477-3210
BOEING EMPLOYEE (ADD SUBSIDIARY)	X Boeing; MDC; BNA	x Boeing; MDC; BNA	x Boeing; MDC; BNA	x Boeing; MDC; BNA
CONTRACT EMPLOYEE				
OTHER (SPECIFY)				
MANAGER'S NAME	Mark Kosai	Mark Kosai	Chris Luke	Chris Luke
PHONE	425-393-2380	425-393-2380	425-393-9907	425-393-9907

C — STATE OF DEVELOPMENT (See Remarks On Back)

DATE CONCEIVED		DATE BUILT	DATE SATISFACTORILY TESTED	
9/2/1998	☐ CONCEPT ONLY X PROVEN ANALYTICALLY X DESIGN COMPLETE	11/5/1998	11/5/1998	X PROTOTYPE ☐ IN PRODUCTION _____ DATE

D — APPLICATION OF THE INVENTION

PRODUCT/PROGRAM	PRODUCTION RELEASE E.G. PRR NO.	DATE
Global Mobile Services		

POTENTIAL CUSTOMER(S) IN ADDITION TO BOEING: Business jet owners, commercial airlines, government and military organizations, commercial cruise ships, commercial shipping lines, oil exploration companies, train operators, long-haul trucking firms

E — DISCLOSURE OF INVENTION OUTSIDE BOEING

DISCLOSED TO:	NAME(S)	DATE(S)
X VENDOR	GTE Airfone, AT&T Claircom, Mentat Inc., Aerocom, EDS, Exodus, BBN, Loral (Space Systems, Cyberstar, Skynet), ViaSat, L-3Com, Hughes Global Services	
X CUSTOMER	GE, Vulcan, Westmount, United Airlines	
OTHER	Various Agencies of the US Government	

PUBLISHED	PUBLICATION NAME	DATE	VOLUME NO.	PAGE
☐ YES X NO				

F — DEVELOPMENT HISTORY

1. WHAT BOEING ACCOUNT OR WORK ORDER WERE YOU CHARGING TO WHEN YOU MADE THIS INVENTION?
   ACCOUNT OR WORK ORDER NO. FOR EACH INVENTOR (16-DIGIT CHARGELINE) 1) 5-7U736-U7GE-AISXXX-7U7GE
   2) _____ 3) _____ 4) _____
2. CHECK AS APPLICABLE:
   - ☐ THIS INVENTION WAS CONCEIVED OR FIRST BUILT AND TESTED IN THE COURSE OF WORK UNDER A U.S. GOVERNMENT CONTRACT.
     CONTRACT NO. OR OTHER IDENTIFICATION _____
   - X THIS INVENTION WAS NEITHER CONCEIVED NOR FIRST BUILT AND TESTED IN THE COURSE OF WORK UNDER A U.S. GOVERNMENT CONTRACT.
   - ☐ THE FOLLOWING ADDITIONAL PARTIES MAY HAVE RIGHTS TO THIS INVENTION: _____
3. RELATED INVENTION DISCLOSURE NOS: _____

DO NOT WRITE BELOW THIS LINE

DISCLOSURE NO.	DATE RECEIVED	DISCLOSURE ASSIGNED TO:	PE	IP
00-070			BWH/BWH	LWN

BOEING
CENTRAL PATENT ENGINEERING

F7 1000 0006 NEW [redacted]

BOEING PROPRIETARY

7734-00129

B

INVENTOR INFORMATION (Use Additional Sheet If Necessary)			
INVENTOR NAME (FIRST, M.I., LAST) 5	INVENTOR NAME (FIRST, M.I., LAST) 6	INVENTOR NAME (FIRST, M.I., LAST) 7	INVENTOR NAME (FIRST, M.I., LAST) 8
Michael de La Chapelle	Paulus J. Martens		
SOCIAL SECURITY NO. 028-36-3800	SOCIAL SECURITY NO. 374-82-6088	SOCIAL SECURITY NO.	SOCIAL SECURITY NO.
ORG. NO. 7-U7DE / MAIL STOP 6E-22	ORG. NO. 7-U7DE / MAIL STOP 6E-22	ORG. NO. / MAIL STOP	ORG. NO. / MAIL STOP
PHONE 425-477-3447	PHONE 425-393-1105	PHONE	PHONE
BOEING EMPLOYEE (ADD SUBSIDIARY): [X] Boeing [ ] MDC [ ] BNA; [ ] CONTRACT EMPLOYEE; [ ] OTHER (SPECIFY)	BOEING EMPLOYEE (ADD SUBSIDIARY): [x] Boeing [ ] MDC [ ] BNA; [ ] CONTRACT EMPLOYEE; [ ] OTHER (SPECIFY)	BOEING EMPLOYEE (ADD SUBSIDIARY): [ ] Boeing [ ] MDC [ ] BNA; [ ] CONTRACT EMPLOYEE; [ ] OTHER (SPECIFY)	BOEING EMPLOYEE (ADD SUBSIDIARY): [ ] Boeing [ ] MDC [ ] BNA; [ ] CONTRACT EMPLOYEE; [ ] OTHER (SPECIFY)
MANAGER'S NAME James C. Jenkins PHONE 425-477-3221	MANAGER'S NAME James C. Jenkins PHONE 425-477-3221	MANAGER'S NAME PHONE	MANAGER'S NAME PHONE

Introduction: Briefly introduce the subject associated with your invention.

Response: This invention provides broadcast video (i.e. television) and data services (i.e. internet) to users on mobile (aeronautical, terrestrial and maritime) platforms, and users in remote locations. The target market for this invention is users who are unable to access other forms of broadband communications and entertainment from conventional media (fiber, cable, etc.). This invention uses existing or planned satellite assets to enable wide-area and wide-bandwidth delivery of services.

The broadcast video services available to users of this invention include commercial Direct Broadcast Satellite (DBS) services (such as DirecTV and Echostar) and rebroadcast video over private Fixed Satellite Services (FSS) or Broadcast Satellite Services (BSS) satellites. The data services provided by the invention include all conventional internet services (e.g. e-mail, web browsing, NetMeeting, etc.), Virtual Private Networks (VPNs) for corporate and government customers, and select World Wide Web (WWW) page content stored on the mobile platform.

The invention is a satellite system and communication network that provides connectivity to mobile platforms using unique antennas, communication waveforms, packet routing protocols, etc. The invention includes methods for establishing broadband connectivity to mobile platforms using "disadvantaged" (smaller than normal aperture) mobile antennas and means to minimize interference to and from other satellite systems in order to comply with Federal Communication Commission (FCC) and International Telecommunication Union (ITU) regulations.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE				
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST		DATE
SIGN [signature] James C. Jenkins Tel:(425)477-3221		7-U7DE	6E-22	SIGN [signature]				
SIGN [signature] Chris P. Luke Tel:(425)393-9907		7-U7DE	6E-22	SIGN [signature]				
				SIGN [signature]				
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 06-070		DATE RECEIVED						

RECEIVED

The invention also includes a means to deliver services to passengers on board mobile platforms through the use of a Local Area Network (LAN). The LAN on the mobile/remote platform provides local portal services such as World Wide Web (WWW) page caching and custom information/entertainment services for the mobile traveler. The invention includes methods for updating cached content on mobile platforms. The terrestrial network component of the invention also provides captive content and caching services, as well as providing a mechanism for periodic updating of the on-board content.

Problem Solved By This Invention: State the existing problem that is solved by your invention.

Response:
Broadband data and video services, on which our modern society and economy have grown to depend, are generally not available to mobile users. While the technology exists to deliver these services to all manner of mobile platforms, past solutions have been very expensive, and only available to very limited markets of government/military users and some high-end maritime markets (i.e. cruise ships). The purpose of this invention is primarily to deliver affordable access to broadband data and video services to the traveling public. In addition to being unaffordable, another problem with existing solutions is their limited capacity. Generally, the existing solutions are not scalable to address the demands of the traveling public.

Finally, no method currently exists for providing high-speed (i.e., > 64 Kbps) data networking services to groups of users on mobile or remote platforms (e.g., airplanes in flight, or ships at sea), nor for the simultaneous provisioning of high-speed networking services and video services to those users. This invention can provide these services to large groups of mobile platforms, such as entire airline fleets (United, American, etc.), with each mobile platform in the fleet having dozens of simultaneous users.

Background: Describe the approaches that are currently used to solve or mitigate the existing problem. Additionally, describe the shortcomings associated with these approaches. Include any related patents or publications that you have knowledge of.

Response:
There are three types of services currently available that provide a limited subset of the services described in this patent application. One such service provides a limited Internet connectivity to users on a mobile platform. The second service provides pre-stored static WWW content on a server located on the mobile platform. The third service provides either TV broadcast services from available Direct broadcast signals, (i.e. Echostar and Direct TV), or provides a custom TV broadcast signal through dedicated satellite links (i.e. Airshow). It is the intent of the invention described in this patent to provide all three of these services through a single installation and with better speed, content, and quality.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN James C. Jenkins Tel:(425)477-3221		7-U7DE	6E-22	SIGN			
SIGN Chris P. Luke Tel:(425)393-9907		7-U7DE	6E-22	SIGN			
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED RECEIVED		SIGN			

(1) There are several operational systems that provide limited Internet data services on commercial airlines and cruise ships. These systems are very limited in their link capability (primarily use communication links developed for telephony) and the service is very expensive (>$1/min for voice connection). For these reasons their market penetration is tiny, and because of inherent limitations on system capacity, there is no room for market growth.

Current operational systems generally use Inmarsat satellite communication links or terrestrial wireless communication links (i.e. NATS) to achieve connectivity to mobile platforms. These connection means have several drawbacks:

(1) Limited connection bandwidth (typically <64 kbps)
(2) Limited overall system capacity (due to limited frequency spectrum)
(3) Very expensive

Inmarsat operates in the L-band frequency spectrum, where there is very little bandwidth and capacity available for providing broadband services to the traveling public. NATS based solutions (i.e. GTE Airfone, AT&T Claircom), familiar to domestic airline travelers who use seatback-mounted telephones, also provides very limited capacity because of operation at L-band, and suffer from the additional problem that connectivity is only available over land. The current mobile platform connection methods are inherently narrow-band and restrict the flow of data to the point where common networking tasks are rendered virtually impossible. Typically this connectivity is achieved through the use of a standard computer modem between the user's computer and the air-ground or ship-shore telephony system. In this scenario, each user gets exclusive use of a full communications channel for the duration of his or her networking session and effectively prevents others from using that portion of the telephony system.

(2) There is one planed service that will provide pre-stored World Wide Web content to users in on a mobile platform. This service will use a server located on the mobile platform to provide its stored content to users on the mobile platform through -a simple touch screen interface. The content located on the server will be updated once every few weeks, while the mobile platform is in an inactive mode, i.e. parked at an airport gate. The update of the data on the mobile platform will be accomplished through loading of CD-ROMS or swapping of hard drives on the server. Although the content stored on the mobile platform with this service can be varied it will never be timely.

(3) There are multiple companies currently engaged in providing or planning to provide live TV content to mobile platforms (DirectTV, AirShow ...). These companies plan to provide either a subset of the direct to home existing broadcast content or pre-packaged airline specific content. Non of the companies planning to provide TV services is planning to customize the broadcast content on the mobile platform or to encapsulate it in IP for broadcast to users personal computers.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN James C. Jenkins Tel:(425)477-3221	[redacted]	7-U7DE	6E-22	SIGN Paulus J. Rotteveel			[redacted]
SIGN Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN W. C. Luke			[redacted]
				SIGN Michael E. Hynek			[redacted]
				SIGN John Hennig			[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED [redacted]					

RECEIVED

Several patents have recently been issued to Boeing's competitors in the Global Mobile business. These patents cover the delivery of video entertainment and data services to airborne platforms. They represent significant prior art to the proposed invention. The very broad claims in these patents (is it possible to patent air?) may make it difficult or impossible to patent this invention. According to instructions from the Boeing Intellectual Property organization staff, the inventors are not to concern themselves with the prior art issues. However, it is important to note that Boeing's involvement in delivering satellite entertainment and data services to commercial aircraft may have preceded the filing dates on these patents.

Boeing has been issued patents pertaining to the design of the phased array antenna (PAA) that is baselined for use on the Global Mobile Services (GMS) program. The Boeing PAA is one possible mobile antenna solution for this invention. This Boeing developed PAA has been sold to several business jet customers who have been using the system reliably for over a year to receive Direct Broadcast Satellite (DBS) transmissions of live TV.

Invention Description: Provide a detailed description of your invention, and illustrate it in a drawing, sketch, or a schematic (if susceptible to illustration). Correlate the illustration with the description by using reference numerals and/or letters. Most importantly, clearly state the novelty of your invention (to the best of your knowledge). The invention description is likely to require more than one page of information.

Top Level Description

The invention is comprised of three principal segments: the Ground Segment (1), the Mobile Segment (2) and the Space Segment (3), as shown in Figure 1. The three segments are interconnected using RF links. RF signals sent between the Ground Segment (1) and the Mobile Segment (2) are transponded through satellites in the Space Segment (3). Mobile platforms (i.e. aircraft, ships, etc.) communicate with ground stations via satellite transponders. All communications "to the users" are considered to be in the "forward direction"; while communications "from the users" are considered to be in the "return direction". The ground stations are connected to a service center that contains servers and routers to collect and direct Internet Protocol (IP) packets to/from external Internet service providers (ISPs) and corporate intranets servers. The network is controlled through the Network Operations Center.

Rebroadcast video content (for example CNN and ESPN) is transmitted to the mobile platforms on transponded radio frequency (RF) links, in the same manner as data content. In addition, mobile platforms may receive DBS transmissions (i.e. DirecTV or Echostar) of live TV. An optional feature of the invention uses a low data rate transponder on a different satellite system to provide transponder coverage in regions not covered by the primary satellite system. For example, in the preferred embodiment of the invention, the primary satellites used to provide broadband data and rebroadcast

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE	
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST M. I. LAST	DATE
SIGN [redacted] James C. Jenkins Tel:(425)477-3221	[redacted]	7-U7DE	6E-22	SIGN [redacted]	[redacted]
SIGN [redacted] Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN [redacted]	[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED [redacted]			

RECEIVED

6/18

video service are FSS satellites operating in the Ku-band, while the back-up satellites for over water coverage may be Inmarsat at L-band.

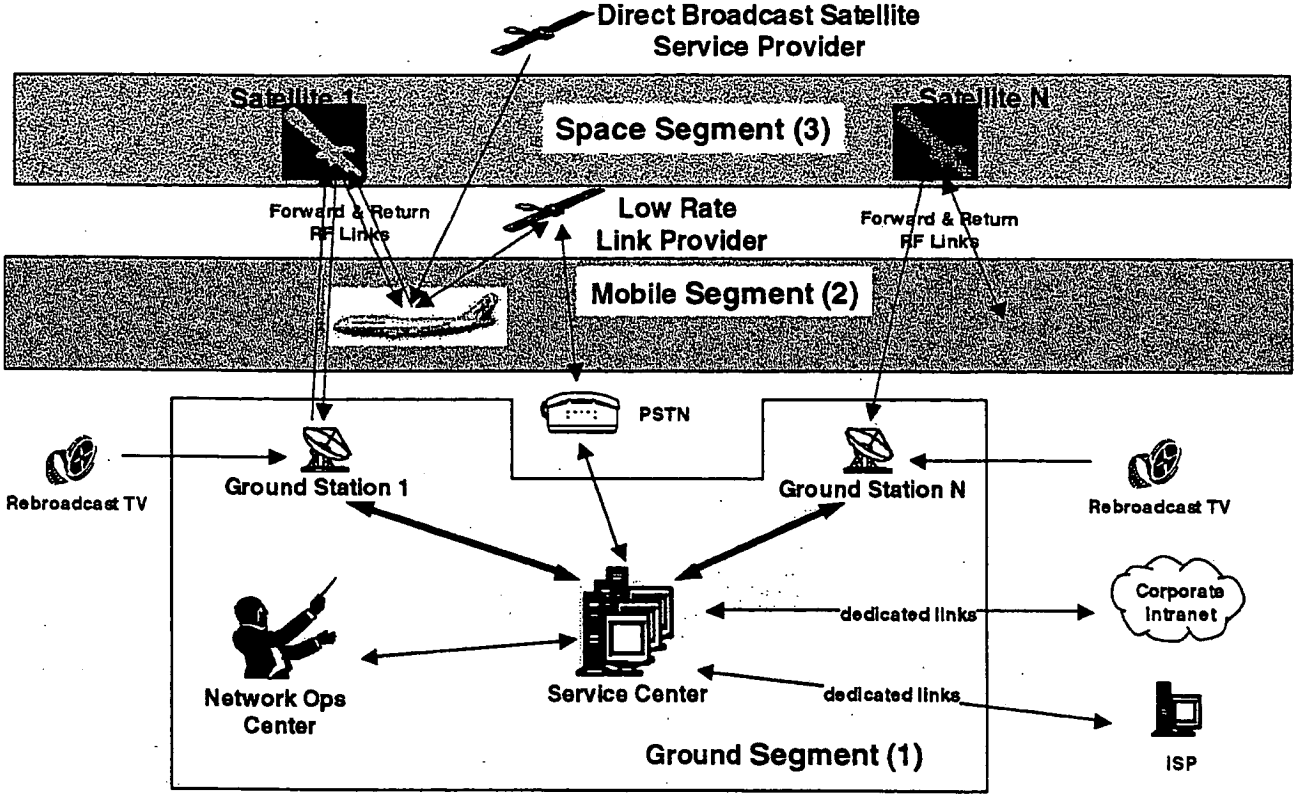

Figure 1. Top Level Pictorial Diagram of Invention

All information sent from the ground station to the mobile platforms is broadcast over the coverage region served by the transponder in use. The mobile platforms receive all broadcast information, and filter the contents using a variety of conditional access and packet addressing schemes (see Figure 2). The forward link employs packet multiplexing to provide multiple access to mobile platforms in the transponder coverage region. The channels used for traffic from the user platforms back to the ground are point-to-point links that are individually assigned and dynamically managed by the system. The preferred multiple access methods for the return link are CDMA, FDMA or FDM-CDMA. Multiple platforms are assigned to each return link transponder, as shown in Figure 3.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST M. I. LAST			DATE
SIGN [redacted] James C. Jenkins Tel:(425)477-3221	[redacted]	7-U7DE	6E-22	SIGN [redacted]			[redacted]
SIGN [redacted] Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN [redacted]			[redacted]
				SIGN [redacted]			[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED [redacted]					

RECEIVED

7/1P

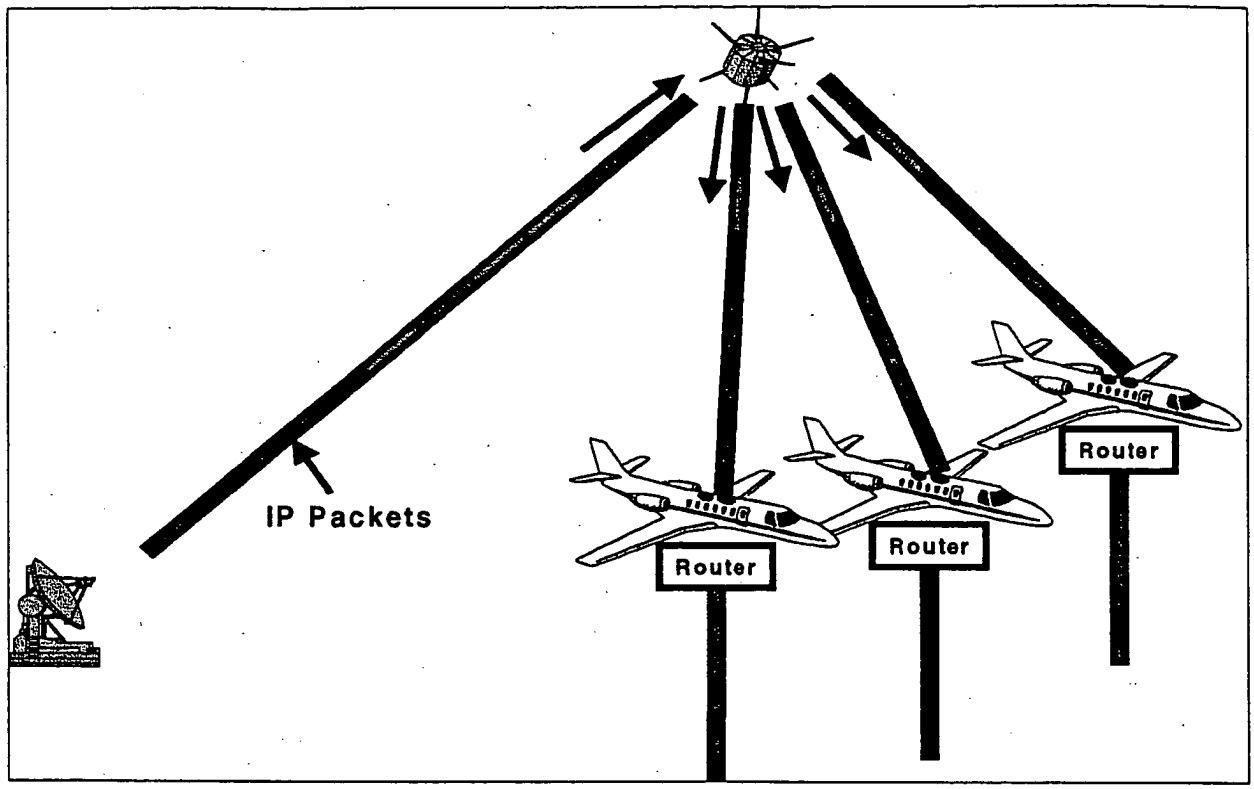

Figure 2. Forward link packet multiplexing multiple access method.

The quantity of satellite transponders required to implement the invention scales with the number of mobile platforms and the data rate demands of each mobile platform. Also, the architecture shown in Figure 1 is repeated in every service region covering the earth. Transponder coverage areas define Service regions. Popular coverage areas for existing transponders include continental US (CONUS), Europe, South/Central America, etc.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN [redacted] James C. Jenkins Tel:(425)477-3221	[redacted]	7-U7DE	6E-22	SIGN [redacted]			[redacted]
SIGN [redacted] Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN [redacted]			[redacted]
				SIGN [redacted]			[redacted]
				SIGN [redacted]			[redacted]

DISCLOSURE NO. (ASSIGNED BY PATENT STAFF)	DATE RECEIVED
00-070	[redacted]

RECEIVED

8/10

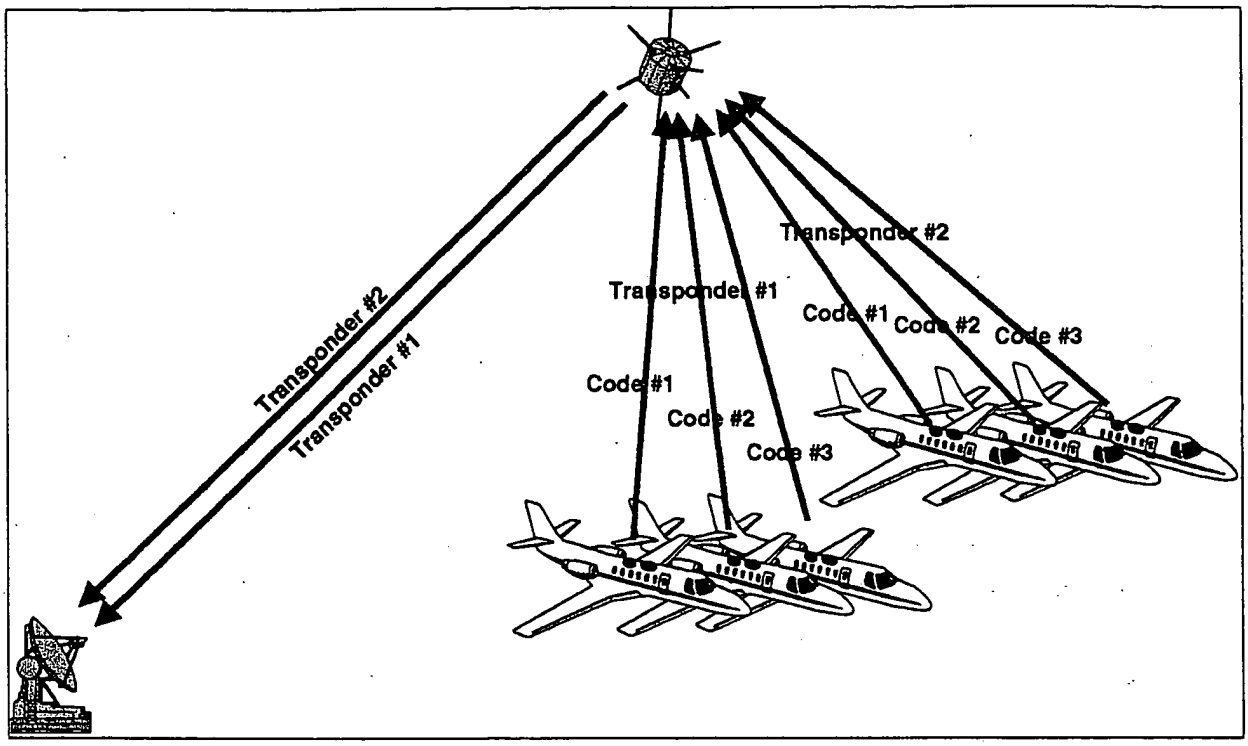

Figure 3. Return link multiple access method.

Mobile Segment

The system elements on the mobile or remote user platform are shown in figure 4. The major elements include the transmit/receive antennas, the communication modems, the server, and the distribution systems. The transmit and receive antennas must have steerable beams that are capable of tracking satellites. They must also have the capability to receive and track the polarization of the satellite transponder. In the preferred embodiment of the invention, the receive antenna implements closed loop tracking of the satellite position and polarization using the forward link signal, and the transmit antenna is slaved to the pointing direction and polarization of the receive antenna. An alternative implementation could use open loop tracking with the pointing direction and polarization determined by knowledge of mobile platform position and attitude (using on-board inertial reference unit) and knowledge of the satellite location.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN [redacted] James C. Jenkins Tel:(425)477-3221	[redacted]	7-U7DE	6E-22	SIGN [redacted]			[redacted]
SIGN [redacted] Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN [redacted]			[redacted]
				SIGN [redacted]			[redacted]

RECEIVED

DISCLOSURE NO. (ASSIGNED BY PATENT STAFF)	DATE RECEIVED
00-070	[redacted]

9/18

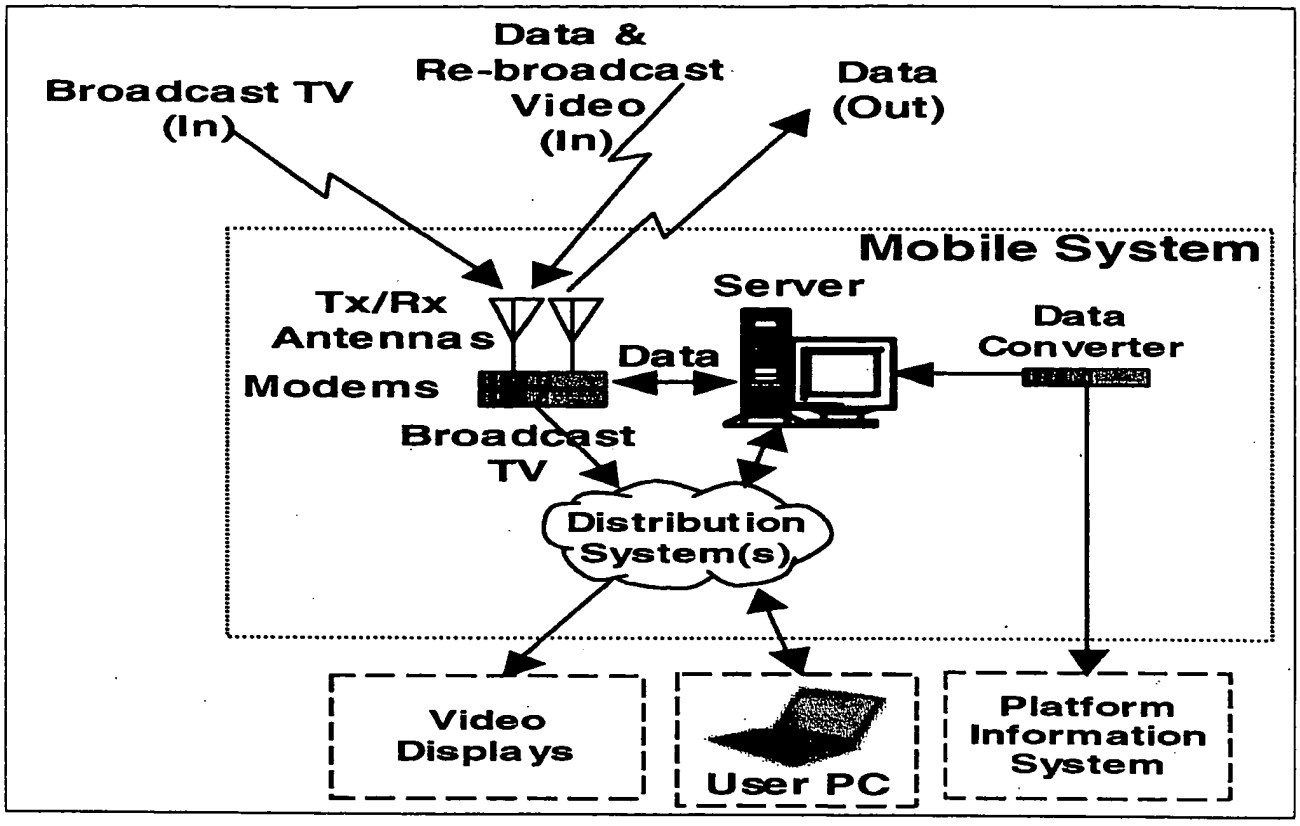

Figure 4. Mobile Segment Block Diagram

The modems that are used to demodulate and decode the forward link receive signals, and modulate and encode the return link transmit signals, must have spread spectrum capability (for reasons described in the Regulatory Compliance section). Received broadcast TV signals (from DBS) are decoded and demodulated in separate Integrated Receiver Decoders (IRDs) from the IRDs used for rebroadcast video and data.

The data and rebroadcast video outputs from the IRDs are fed to a server that filters off only the IP packets addressed to users on the mobile platform. These packets are then routed to the proper destination or user via the on-board distribution system. The invention can be implemented using separate distribution systems for data and video or there may be a single distribution system to carry both. The user PCs may be used as a video display, or the broadcast & re-broadcast TV may be sent to separate video displays. Other user devices for interacting and interfacing to the system include touchscreen displays, handheld personal information managers, etc., or they can take the form of passive devices for video/audio delivery like TV monitors or headphones.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN James C. Jenkins Tel:(425)477-3221	[redacted]	7-U7DE	6E-22	SIGN			[redacted]
SIGN Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN			[redacted]
				SIGN			[redacted]

RECEIVED

DISCLOSURE NO. (ASSIGNED BY PATENT STAFF)	DATE RECEIVED
00-070	[redacted]

F7 1000 0006 NEW [redacted]

10/18

The server contains cached WWW pages and hosts the Internet portal for the mobile platform. The server also buffers and formats the data for transmission on the return link. Caching content on the server is important for reducing loading on the RF links and for improving the quality-of-service by decreasing response time (e.g., no GEO transmission delay is incurred when accessing cached information off the server). The portal hosted on the server is an important element in the business strategy for GMS. Large advertising and on-line shopping revenue is expected from operation of an Internet portal tailored to the needs and interests of the traveling public.

The final element of the mobile system is a data converter unit. This unit is used for applications of the invention that require the passing of data between the platform information system and some ground entity (such as an airline fleet operations center, or maintenance center). For commercial aircraft, the data converter is connected to an avionics bus such as ARINC 629 for real-time transmission of flight data to the ground and the conveyance of crew information services (CIS).

Space Segment

The space portion of the system uses satellite transponders located in Geostationary (GSO) or non-geostationary (NGSO) orbits. Examples of possible NGSO orbits that could be used with this invention include low earth orbit (LEO), medium earth orbit (MEO) and highly elliptical orbit (HEO). The transponders provide "bent-pipe" communications channels between the user platforms and the satellite ground stations. The frequency bands used for these communication links could be anything from VHF to W-Band and beyond. In fact, because commercial jets and business jets typically cruise high above clouds and much of the earth's atmosphere, laser communication may even be practical. The most common embodiment of the invention would use leased Ku-band transponders in the frequency band designated by the FCC and ITU for Fixed Satellite Services (FSS) or Broadcast Satellite Services (BSS). The invention may use different types of transponders, operating at various different frequencies, to provide connectivity in different regions of the earth.

Key requirements for satellite transponders used with this system include wide geographic coverage, high Effective Isotropic Radiated Power (EIRP) and high Gain/Noise Temperature (G/T). Transponder coverage is an issue for this invention because most communication satellite transponders cover only populated landmasses. The biggest market for the invention is commercial aircraft that fly for extended periods of time over water and remote regions (including polar regions) of the earth where there is little or no transponder coverage. A variety of solutions have been contemplated for this problem including use of Inmarsat satellites over water, launching new GSO satellites with ocean coverage, or launching a new constellation of NGSO satellites to provide full earth coverage (including the poles). The invention will work with any of these solutions.

The invention also includes a means and apparatus for receiving Direct Broadcast Satellite (DBS) transmissions for live TV (news, sports, weather, entertainment, etc.). Examples of domestic DBS

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN James C. Jenkins Tel:(425)477-3221	[redacted]	7-U7DE	6E-22	SIGN			[redacted]
SIGN Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN			[redacted]
		RECEIVED		SIGN			[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		[redacted]					

11/18

service providers include DirecTV and Echostar. DBS transmissions occur in a frequency band designated for Broadcast Satellite Services (BSS). The FSS frequency band that carries the data services (in the preferred embodiment of the invention) and the BSS frequency band that carries broadcast TV are adjacent to each other in the Ku-band. In the preferred embodiment of the invention, a single Ku-band receive antenna (such as the patented Boeing Phased Array Antenna) can be used to receive either broadcast TV in the BSS band, or data services in the FSS band, or both simultaneously using the same antenna. This is a key feature of the invention.

Ground Segment

The terrestrial network hosts ground-based data and video services, routes content to the appropriate user platforms on demand or by prearranged schedule, and provides connectivity between the satellite segment and external sources of information. It also includes the terrestrial satellite communications equipment necessary to establish communications links to the satellites. Other functions performed by the terrestrial network include traditional network management, user authentication and accounting, customer service, and billing.

Invention Features for Regulatory Compliance

The transmit antenna used by the mobile segment presented significant regulatory challenges that were solved by the invention in unique ways. Antennas used for mobile applications tend to be smaller than conventional Very Small Aperture Terminal (VSAT) antennas (typically reflector antennas that are one meter in diameter). Mobile transmit antennas used for aeronautical applications must have low aerodynamic drag, light weight, low power consumption and be of small size. For all these reasons, the antenna aperture (the active region of the antenna) is smaller than a conventional VSAT antenna. VSAT antennas are sized to create an antenna beam that is narrow enough to illuminate a single FSS satellite along the GEO arc (FSS satellites are spaced at 2 degree intervals). The smaller than normal antenna aperture, of the mobile transmit antennas used for this invention creates antenna beams that are wide enough to illuminate the receiving satellites nearest neighbors along the GEO arc. This can create an interference problem and potentially violates FCC and ITU regulations.

The invention solves this problem by using spread spectrum modulation techniques on the return link. The transmitted signal is spread in frequency to produce an interfering signal at the adjacent satellite that is below the threshold EIRP spectral density at which the signal would interfere. It has been shown through analysis that compliance with FCC and ITU interference is possible for transmit antenna apertures as small as 6"x6".

A similar problem and solution occur on the forward link. Again, the Aero-mobile receive antennas are generally smaller than conventional VSAT antennas so their beam encompasses the adjacent satellites along the GEO arc. In this case, the problem is interference signals from other satellites into the receive antenna. To overcome this interference the invention uses a smaller than normal forward link data rate. For instance, the invention can operate at a maximum forward link data rate of 5 Mbps using a typical

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN James C. Jenkins Tel:(425)477-3221	[redacted]	7-U7DE	6E-22	SIGN			[redacted]
SIGN Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN			[redacted]
				SIGN			[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED					

RECEIVED

[redacted]

12/18

FSS transponder (e.g., Telestar-6) and the Boeing patented PAA having an active aperture of 17"x24". Using a standard Digital Video Broadcast (DVB) waveform, the forward link signal would occupy less than 8 MHz out of a total transponder bandwidth of 27 MHz.

Concentrating the transponder power in less than the full transponder bandwidth creates a regulatory problem because the FCC regulates the maximum EIRP spectral density from a transponder to prevent interference between satellite systems. Just as on the return link, the solution used by this invention is to employ spread spectrum modulation to spread the forward link signal over the transponder bandwidth.

Air Telephone System Return Link Option

Information traffic on the return link, from the mobile platform, uses wireless links to reach the destination. In this optional method, line-of-sight links to terrestrial ground stations provide the physical infrastructure. For example, air telephone systems can be used for low-data-rate return links (2.4 to 9.6 kbps). The air telephone systems (e.g., NATS in North America) were designed for carrying voice telephony traffic, but have been adapted to pass single-user-per-call, point-to-point, analog modem data. In the present invention, the aggregate return link traffic from the onboard network is combined via a router, switch or PBX and then coupled into the air telephone return link via an analog modem, or directly via a digital interface (e.g., CEPT-E1). Expanded capacity can be provided by establishing multiple simultaneous connections from the router/switch into the air telephone system. The airborne router/switch has a corresponding unit in the system NOC that demodulates and recombines the split traffic back into a single aggregate data stream from the onboard network. Multi-link Point to Point (PPP) data encapsulation can be used to accomplish the splitting/recombining of the data streams between the airborne and NOC router. In addition to expanded capacity, the tolerance to a single connection failure is increased with multiple connections through the air telephone system. Notice that the hand-over between ground stations is managed by the air telephone system and the connection between the respective air and ground routers is automatically maintained as the mobile platform traverses multiple ground station coverage areas.

External Information Services

The external information services include entities normally considered to be outside of the scope of the system described in this invention. They are, however, an integral part of the services provided by the system since they are ulitmately the source for most of the content provded as part of the system services. The terrestrial network segment provides connectivity to the external information services primarily through either an Internet connection or by means of leased dedicated connections. Secondary connection methods are available from virtual private network (VPN) connections over the public Internet or through the public switched telephone network (PSTN).

Services Provided by the Invention

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN [redacted]		7-U7DE	6E-22	SIGN [redacted]			
James C. Jenkins Tel:(425)477-3221				SIGN [redacted]			
SIGN [redacted]		7-U7DE	6E-22	SIGN [redacted]			
Chris P. Luke Tel:(425)393-9907				SIGN [redacted]			
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED [redacted]					

RECEIVED

The system can be used to provide a variety of information and communication services, among which are commercial broadcast television, rebroadcast television, private portal data content, Internet connectivity, private corporate network connectivity, and airplane/ship crew information services. These services are described in the following paragraphs.

Broadcast Television Services

Commercial broadcast television services are provided by receiving existing BSS or FSS broadcasts (e.g., DirecTV) through the hardware and software elements present on the user platform. The antenna subsystem directs the antenna beam towards the appropriate satellite and continuously tracks the satellite during flight. The receive/transmit subsystem tunes to the appropriate signal, decodes it, and authenticates it against the conditional access security system. The control subsystem routes the decoded video signal either to the distribution system for immediate viewing or to a video server for archiving and later viewing.

Rebroadcast Television

Rebroadcast television or customized video services are received and processed on the user platform in exactly the same way. The difference is in how the signals are provided. Whereas the commercial broadcast signals are provided by other commercial entities, the rebroadcast or customized video content is obtained from the content source through the terrestrial network. The video content is appropriately encoded for transmission, and then broadcast over the satellite assets that form a part of the system of this invention. Some customization of the rebroadcast content may occur on the mobile platform server to tailor the advertisements and information content to the particular market and interests of users on that platform. The rebroadcast content is considered to be private to the system, and is not made available to other receiver systems or customers.

Portal & Caching

The bulk of the data content provided to mobile/remote customers is provided using a private portal data content. This is implemented as a set of HTML pages housed on a world-wide-web server on the platform. The content is kept fresh by periodically sending updated portions from a server and scheduling function located in the terrestrial network. It is envisioned that this web server will also be configured to accept user logon information to support authentication and authorization of users, and to keep track of user and network accounting metrics to support a billing system and a network utilization model. The authorization and accounting systems will communicate with terrestrial-based services to transfer the accumulated data at convenient intervals.

The system also provides direct Internet connectivity for a variety of purposes, such as when a mobile/remote user desires to obtain data content that is not available from the private portal, or as an avenue for content sources to provide fresh content for the private portal.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN [redacted]	[redacted]	7-U7DE	6E-22	SIGN [redacted]			
James C. Jenkins Tel:(425)477-3221				SIGN [redacted]			
SIGN [redacted]		7-U7DE	6E-22	SIGN [redacted]			
Chris P. Luke Tel:(425)393-9907				SIGN [redacted]			
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE [redacted]					

RECEIVED

BOEING

In order to expedite direct Internet access by the mobile/remote users, the host platform will contain a cache server. The cache server will be able to cache the most frequently requested web pages as well as contain a Domain Name System (DNS) lookup table of the most frequently accessed domains. The DNS lookup table will be maintained by the terrestrial network and will be periodically updated on the mobile platform. The invention may use any of the following methods for refreshing the cached content of the portal:

(1) In-flight periodic pushed cache refresh.
(2) Cache refresh at the gate using Gatelink or other wireless connection to the aircraft.
(3) Manual cache refresh by crewmember carrying on a CD ROM and inserting it into the server.

Methods (2) and (3) have the advantage of not requiring any capacity on the expensive satellite links. Method (1) can best be implemented by pushing cache updates only during times when capacity is available on the transponder (avoiding peak busy hour).

Virtual Private Networks (VPNs)

An alternate use of the invention is to provide video and data connectivity for mobile/remote users between the user platform and the user's private corporate or government network. This would allow the mobile/remote user to send and receive email and maintain communications with his/her office while located on a mobile/remote platform. Connectivity with private networks would be provided through private leased lines between the terrestrial network and the customer network, or through VPNs carried over the public Internet.

Crew Information Services

One other class of service that can be provided by this system is airline/ship crew information services. These services are being provided today by a combination of narrow-bandwidth radio communications services for critical real-time data transfer and manual transfer of data recording media (disks, tapes) after the airplane lands or the ship docks. By using the system described in this invention disclosure, the airlines/ships can transfer critical data both to and from selected airplanes/ships or groups of airplanes/ships at high speed and in real time.

Technical Maturity: What is the state of development? Provide evidence that your invention concept has been sufficiently developed that there is little technology risk associated with its implementation. Results from analysis, simulation/modeling, or prototype testing are preferred.

Response: All elements of the system described by the invention have been successfully prototyped and demonstrated. The ground-based elements of the system are now considered to be in a beta-test configuration and will be elevated to a production level prior to June of 2000. The space-based elements of the system are under long-term lease agreements. The mobile platform elements of the

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN [redacted] James C. Jenkins Tel:(425)477-3221	[redacted]	[redacted]-U7DE	6E-22	SIGN [redacted] SIGN [redacted]			[redacted]
SIGN [redacted] Chris P. Luke Tel:(425)393-9907	[redacted]	[redacted]U7DE	6E-22	SIGN [redacted] SIGN [redacted]			[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED [redacted]					

RECEIVED

system have been installed on several aircraft and ships and have been used in successful demonstrations of the invention.

In addition, the proposed invention has been extensively reviewed by several outside companies and potential venture partners who are world-class providers of products and services relating to the invention (i.e. Space Systems Loral, Loral Cyberstar, Loral Skynet, BBN, ViaSat, L-3COM, etc.).

Development of this system has occurred over several years and has consumed tens of millions of dollars. As such, the system has been extensively analyzed and tested, with far too much data generated to include in this Invention Disclosure. Here is a partial list of key tests and analyses that have been performed to verify and demonstrate the system:

(1) Forward link demonstration using Telstar 6 satellite (FSS) to Seattle (worst-case CONUS location) using Boeing Phased Array Antenna (PAA). Demonstrated link closure at greater than 5 Mbps at all antenna attitudes encountered in aircraft cruise and various weather conditions.
(2) Return link demonstration using Telstar 6 satellite from Seattle (worst-case CONUS location) using 256-element Boeing transmit PAA. Demonstrated link closure at greater than 128 Kbps at all antenna attitudes encountered in aircraft cruise and various weather conditions.
(3) Same demo as (1) using GE-4 satellite (FSS). Closed forward link at over 10 Mbps.
(4) Simultaneous broadcast of video services (from DirecTV) and data services (from GE-4) were demonstrated using Boeing receive PAA.
(5) Complete network demonstration for United Airlines and Phil Condit using Telstar 6 forward link. Live video (CNN) and Internet services (e-mail, web browsing, etc.) delivered to notebook computers connected on a LAN. Custom Boeing Internet portal was successfully demonstrated.
(6) Compliance with FCC (25.209) and ITU (S9.6/1060) regulations for interference produced by Boeing Transmit PAA has been demonstrated through analysis.
(7) Analyses have shown that forward and return link operation outside of CONUS using available leased FSS transponders is possible at data rates similar to what has been demonstrated in CONUS.

Technical Value: Provide evidence that your invention represents a significant advance in a technology area important to the success of Boeing, whether or not currently used. Quantitative data, such as trade study results, supporting the claimed benefits of your invention are preferred.

Response:
This invention involves several core product areas for the Boeing Company:

(1) Information Services
(2) Communication Systems
(3) Space Systems
(4) Commercial Airplanes (including BBJs)
(5) Military Airplanes

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN [redacted] James C. Jenkins Tel:(425)477-3221	[redacted]	-U7DE	6E-22	SIGN [redacted]			[redacted]
SIGN [redacted] Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN [redacted]			[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED RECEIVED					

All these product areas have been identified as critical to Boeing's future success. In addition, the invention has application to both commercial and government/military markets.

As for the question of whether the invention represents a significant advance in technology, the answer is clearly yes, since there is no system to provide video entertainment and data services to mobile/remote users in wide use today. There is plenty of quantitative data to support the claimed benefits of the system, but the inventors believe that the best proof of the claimed benefits is that the system has been demonstrated (see previous section).

Business Maturity: Provide specific plans to incorporate the invention into an existing or planned Boeing Program or contract opportunity. If available, provide the name(s) of Boeing Program Manager(s) who are aware of your invention and would likely support seeking patent protection for your invention.

Response: The GMS program has a business plan that has been reviewed and approved at the highest levels of the company. This invention is a key element of the Global Mobile Services business plan. The program manager is Richard A. Vandermeulen and the Boeing executives who back this program (and hence this invention since this invention is the GMS system architecture) include Ken Medelin (VP, Information & Communication), Jim Albaugh (President, Space & Communications) and Phil Condit. In fact, Phil has taken a personal interest in the GMS program and he will be one of the first customers for this invention (on his Boeing Business Jet).

This invention is the system architecture for the GMS program. We are executing a plan to use this invention as the basis for a revenue generating service starting in 2001. We are in negotiations with major corporate customers such as United Airlines, GE and Vulcan to provide video and data services to airlines and business jets.

Business Value: Respond to each of the following questions.

1. Will this invention make our products or services more competitive (such as: reduced operating cost, less fuel burn, less maintenance, reduced crew, lower noise, more payload-more seats/cargo, greater range, quicker turnaround, improved passenger comfort/amenities, supports weapon systems platforms, supports R&D contract services, or supports commercial space ventures)? Example: adds 5 seats, decreases fuel burn by 2%.

Response:
Yes. This invention is a new product and service for Boeing in a business area (Information Technology) that The Boeing Company wants to aggressively grow. Teledesic and Ellipso were two

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN [redacted] James C. Jenkins Tel:(425)477-3221	[redacted]	U7DE	6E-22	SIGN [redacted]			[redacted]
SIGN [redacted] Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN [redacted]			[redacted]
				SIGN [redacted]			[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED [redacted]					

RECEIVED

17/18

previous attempts at establishing Boeing as a key player in the satellite communication business. The billions of dollars in capital investment and the uncertainty of competition against the rapidly developing terrestrial communication system, made these ventures too risky. GMS has neither of these problems. First, the system (our invention) is initially implemented using existing leased transponder assets. As demand grows, we will increase the quantity of leased transponders, which avoids the large debt that is incurred in a satellite venture such as Teledesic. Second, because the market for this invention is mobile users, there is no direct competition from terrestrial wire (cable, DSL, etc.) and fiber broadband services. In a sense, the mobile market is a captive market.

This invention may be used to leverage the sale of other Boeing products such as commercial airplanes, business jets, military airplanes and satellite systems. Any mobile or remote platform equipped with this invention will provide greater access to video and information services, and greater operator access to essential information services. Military aircraft or ships equipped with this invention will provide greater access to sensitive military information and more timely exchange of critical information.

2. Will this invention improve our processes (such as: reduced fabrication cost, lower cycle time, lower inventory, lower defect rate, improved safety, better repair methods)? Example: Reduces cycle time from 6 hours to 2 hours, reduces defect rate from 20% to 2%.

Response: No. This invention relates to a method and apparatus for providing a new service.

3. Do we have competitors on programs or proposals affected by this invention?

Response:
Yes. There are formidable competitors (e.g. AirShow, Rockwell-Collins, ViaSat, DirecTV) that have proposed systems that are similar to the invention and that are aggressively pursuing the same core market (airlines and business jets). Boeing is currently competing against these companies for a major contract to supply live TV and Internet services on United Airlines' entire domestic fleet of aircraft. Ownership of intellectual property may well become a key factor in the battle for these markets.

4. Is this invention likely to produce significant licensing revenue?

Response:
Yes it could, but the current business plan calls for Boeing to establish a new business venture based on the use of this invention, so it is unlikely that Boeing will choose to license the invention. However, if Boeing were to decide not to proceed with the GMS program, then there are a variety of ways in which this invention could be marketed or otherwise exploited. If the technology were to be licensed to third-party service providers, the licensing revenue could be substantial.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M.I.	LAST	DATE
SIGN [redacted] James C. Jenkins Tel:(425)477-3221	[redacted]	U7DE	6E-22	SIGN [redacted]			[redacted]
SIGN [redacted] Chris P. Luke Tel:(425)393-9907	[redacted]	7-U7DE	6E-22	SIGN [redacted]			[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE [redacted]					

RECEIVED

10/10

Infringement Detectability: If the invention is used, outside the company, would its use be detectable? If so, how?

Response:
It is highly probable that Boeing would be aware of any system to provide data and/or video entertainment services that is deployed on airlines, business jets and military platforms. Since these platforms make up our core business. Boeing is intimately familiar with these systems, including the In-Flight Entertainment (IFE) systems used on Commercial airplanes, there is almost no chance that an infringement of a patent based on this invention would escape the attention of Boeing.

The bottom line is that if the GMS program continues, then we will be very vigilant about our competition and everything they do will be scrutinized. So there is no possibility that a patent infringement will be over looked.

THE FOREGOING WAS EXPLAINED TO AND UNDERSTOOD BY ME				INVENTOR(S) SIGNATURE			
WITNESSES SIGNATURES (AT LEAST TWO)	DATE	ORGN. NO.	MAIL STOP	FIRST	M. I.	LAST	DATE
SIGN [redacted] James C. Jenkins Tel:(425)477-3221	[redacted]	U7DE	6E-22	SIGN [redacted]			[redacted]
SIGN [redacted] Chris P. Luke Tel:(425)393-9907	[redacted]	Z-U7DE	6E-22	SIGN [redacted]			[redacted]
				SIGN [redacted]			[redacted]
DISCLOSURE NO. (ASSIGNED BY PATENT STAFF) 00-070		DATE RECEIVED [redacted]					

RECEIVED